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13. ABSTRACT (Maximum 200 words)

The main goal of this project was to study and develop wavelet-based image and video compression algorithms, with focuses on algorithmic performance, image quality, and bandwidth optimization. This was accomplished by applying advanced statistical modeling to develop efficient image/video compression, incorporating task-oriented performance criteria for algorithmic optimization, and implementing wavelet-based video coding algorithms. This report is a summary of the work performed under this grant.

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DAAH04-96-1-0227

Period of Performance: 1 July 1996 – 30 June 2000

Title: "Wavelet Based Coding of Images and Video"

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The main goal of this project was to study and develop wavelet-based image and video compression algorithms, with focuses on algorithmic performance, image quality, and bandwidth optimization. This research group has been a leader in the study and development of wavelet transform-based image compression algorithms, and the algorithms introduced under this grant by the group are among the current state-of-the-art in image compression technology. The wavelet transform provides a signal expansion that compactly represents energy that is localized either in frequency (for example, low-pass energy, narrow-band energy, and so on) or in space (for example, edges in images, impulses, and so on). Natural images typically contain a rich mixture of large spatial regions of frequency-localized energy (smooth regions) and spatially-localized, wide-band energy (points, lines, and edges). Wavelets offer a natural framework for efficiently managing this mixture of information. The research focused on understanding the rich relationship among coefficients in the wavelet expansion of natural images, and in developing data-structures to fully exploit those relationships.

Consecutive frames from typical video sequences contain highly redundant information, due to the high frame-sampling rate needed to portray motion accurately. However, various complex modes of motion make it difficult to exploit this redundancy between frames in video compression. Methods both for representing the motion in a video sequence, and for using motion information to represent the video sequence itself more efficiently were studied and developed. Overlapped-block motion compensation (OBMC) was proposed and analyzed as a more efficient type of block-based motion compensation used in most video coding standards, and a version of OBMC has been adopted by recent video coding standards (H.263 and MPEG-4). Also developed were the Estimation-Quantization Coder (EQC) and the Space-frequency Quantization (SFQ) coder. EQC incorporates better statistical characterizations of motion-compensated prediction residuals, to improve video coding efficiency. SFQ jointly optimizes the balance between choosing a large subset of coefficients to be scalar quantized with low precision and a small subset of coefficients to be scalar quantized with high precision. In addition, this research was integrated into the newly formed New Jersey Center for Multimedia Research, funded by the New Jersey Commission Science and Technology. This center brings together researchers from industry and academia involved in all aspects of multimedia technology, including algorithms, implementations, and applications.

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